US009150374B2

(12) **United States Patent**
Ohmura

(10) **Patent No.: US 9,150,374 B2**
(45) **Date of Patent: Oct. 6, 2015**

(54) **DANCER ROLLER APPARATUS**

(71) Applicant: **Yuuji Ohmura**, Ibaraki (JP)

(72) Inventor: **Yuuji Ohmura**, Ibaraki (JP)

(73) Assignee: **Ricoh Company, Ltd.**, Tokyo (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 213 days.

(21) Appl. No.: **13/865,498**

(22) Filed: **Apr. 18, 2013**

(65) **Prior Publication Data**

US 2013/0277487 A1 Oct. 24, 2013

(30) **Foreign Application Priority Data**

Apr. 23, 2012 (JP) 2012-097800

(51) **Int. Cl.**
B65H 23/16 (2006.01)
B65H 23/188 (2006.01)
B65H 26/02 (2006.01)
B65H 20/34 (2006.01)

(52) **U.S. Cl.**
CPC ***B65H 23/1888*** (2013.01); ***B65H 20/34*** (2013.01); ***B65H 26/025*** (2013.01); *B65H 2403/72* (2013.01); *B65H 2408/2171* (2013.01); *B65H 2511/112* (2013.01); *B65H 2513/10* (2013.01); *B65H 2513/11* (2013.01); *B65H 2553/51* (2013.01); *B65H 2801/15* (2013.01)

(58) **Field of Classification Search**
USPC 242/390.6, 390.9, 417.2, 418.1, 419.1, 242/419.9, 420.3, 420.4, 420.6, 421.5, 242/412.2, 413.3; 226/118.2, 118.3
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,223,822	A *	9/1980	Clitheroe	226/42
5,050,812	A *	9/1991	Mueller	242/418.1
6,050,517	A	4/2000	Dobrescu et al.	
6,267,283	B1	7/2001	Vogt	

FOREIGN PATENT DOCUMENTS

DE	1 916 892	A1	12/1970
EP	0 989 084	A2	3/2000
JP	03-050128	Y2	10/1991
JP	2002-029652		1/2002
JP	2007-230719		9/2007
JP	2009-073587	A	4/2009

OTHER PUBLICATIONS

Extended European Search Report issued Apr. 8, 2014 in Patent Application No. 13164152.4.

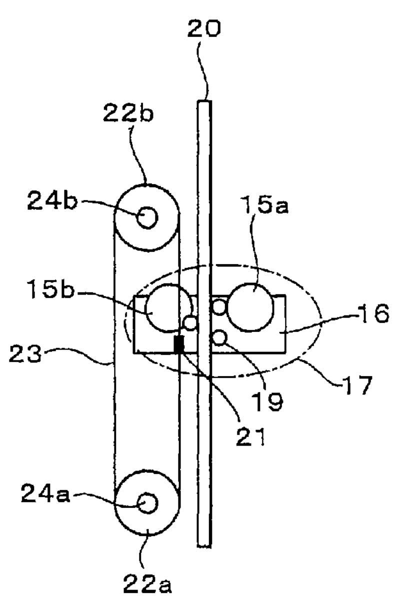
* cited by examiner

Primary Examiner — Sang Kim
(74) *Attorney, Agent, or Firm* — Oblon, McClelland, Maier & Neustadt, L.L.P.

(57) **ABSTRACT**

A dancer roller apparatus is disclosed. The apparatus includes a dancer roller; a drive motor; and a dancer roller position changing unit, wherein the dancer roller position changing unit is provided with a one way clutch which allows the dancer roller to move in a long object slack direction, and wherein the drive motor is caused to rotate in a direction such that the dancer roller moves the one way clutch in a long object stretching direction during conveying of a long object.

8 Claims, 11 Drawing Sheets



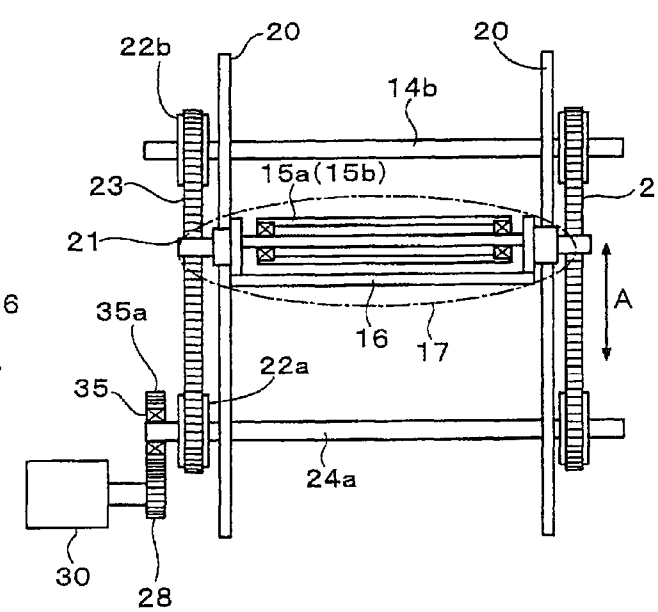


FIG.1A

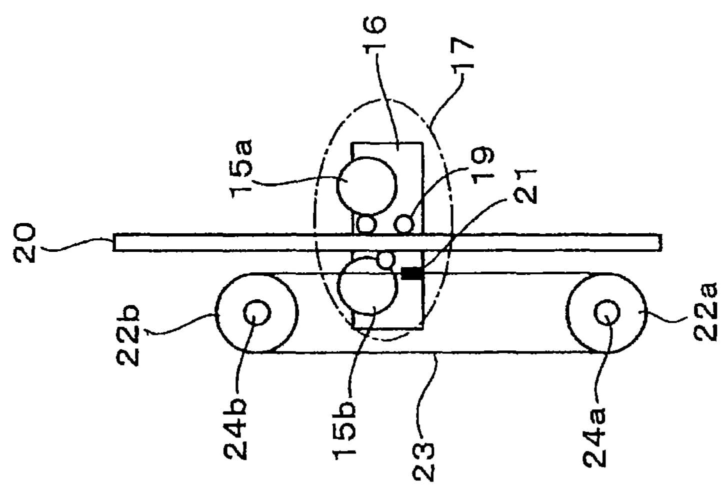

16
17
15a
19
21
20
22b
22a
24b
15b
23
24a

FIG.1B

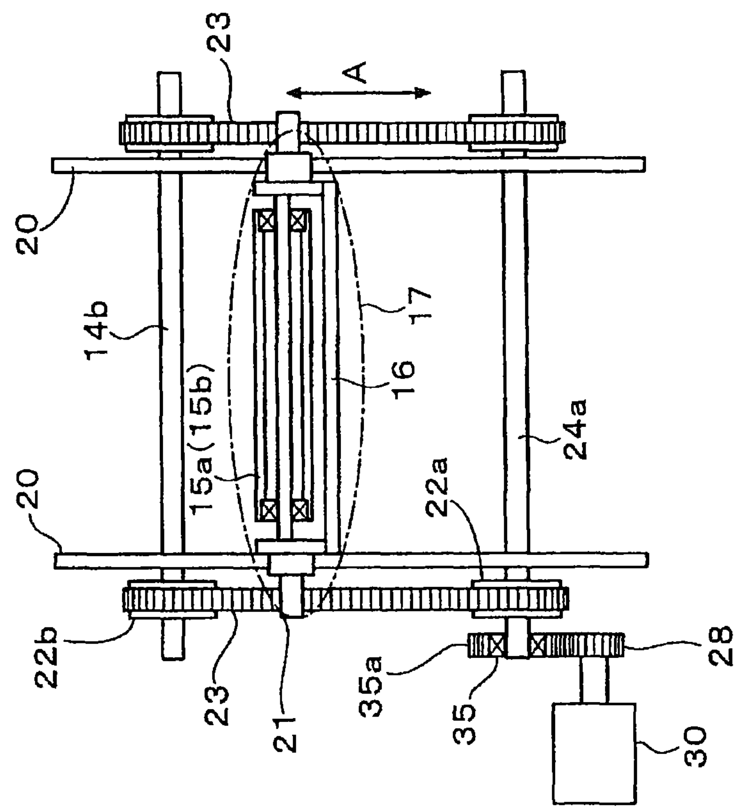

23
A
20
14b
17
16
15a(15b)
24a
22a
20
22b
23
21
35a
35
28
30

FIG.2C

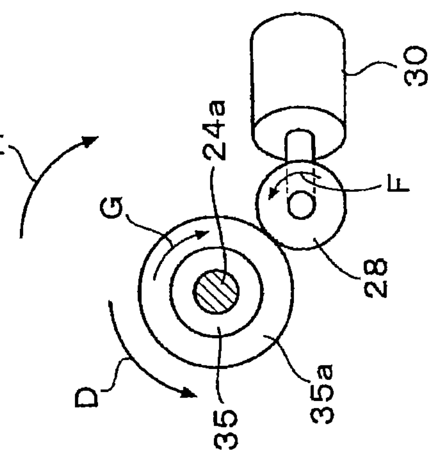


FIG.2B

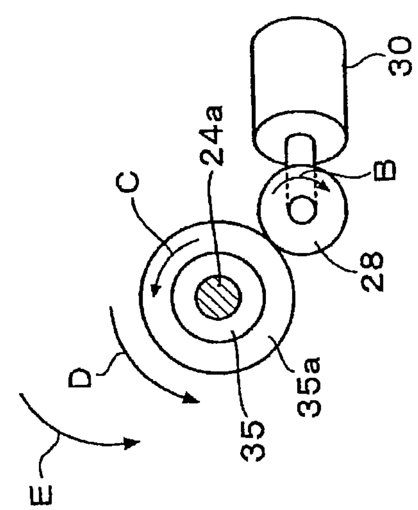


FIG.2A

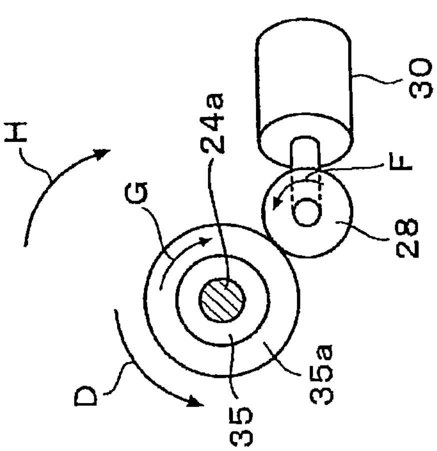
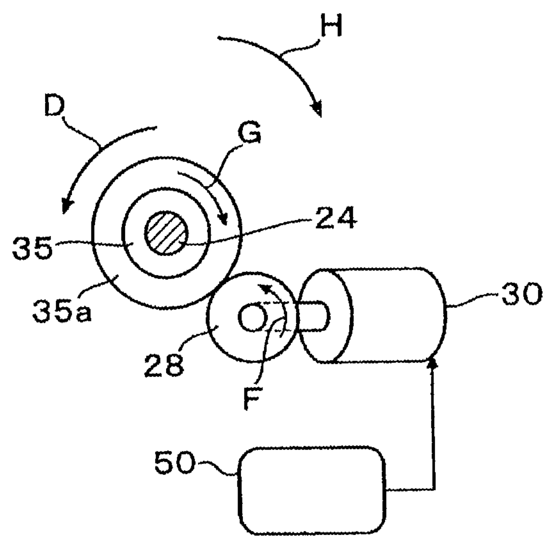


FIG.3



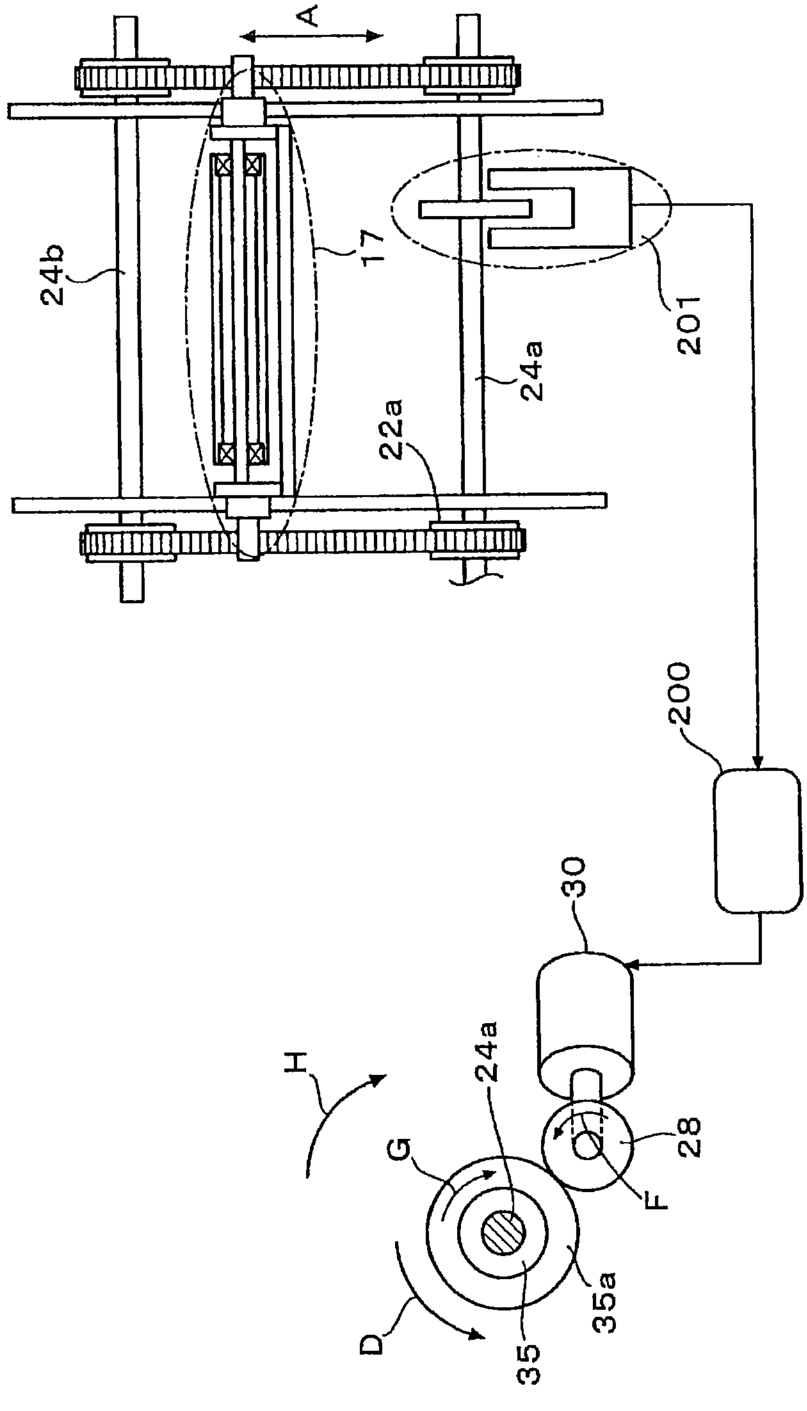


FIG.4

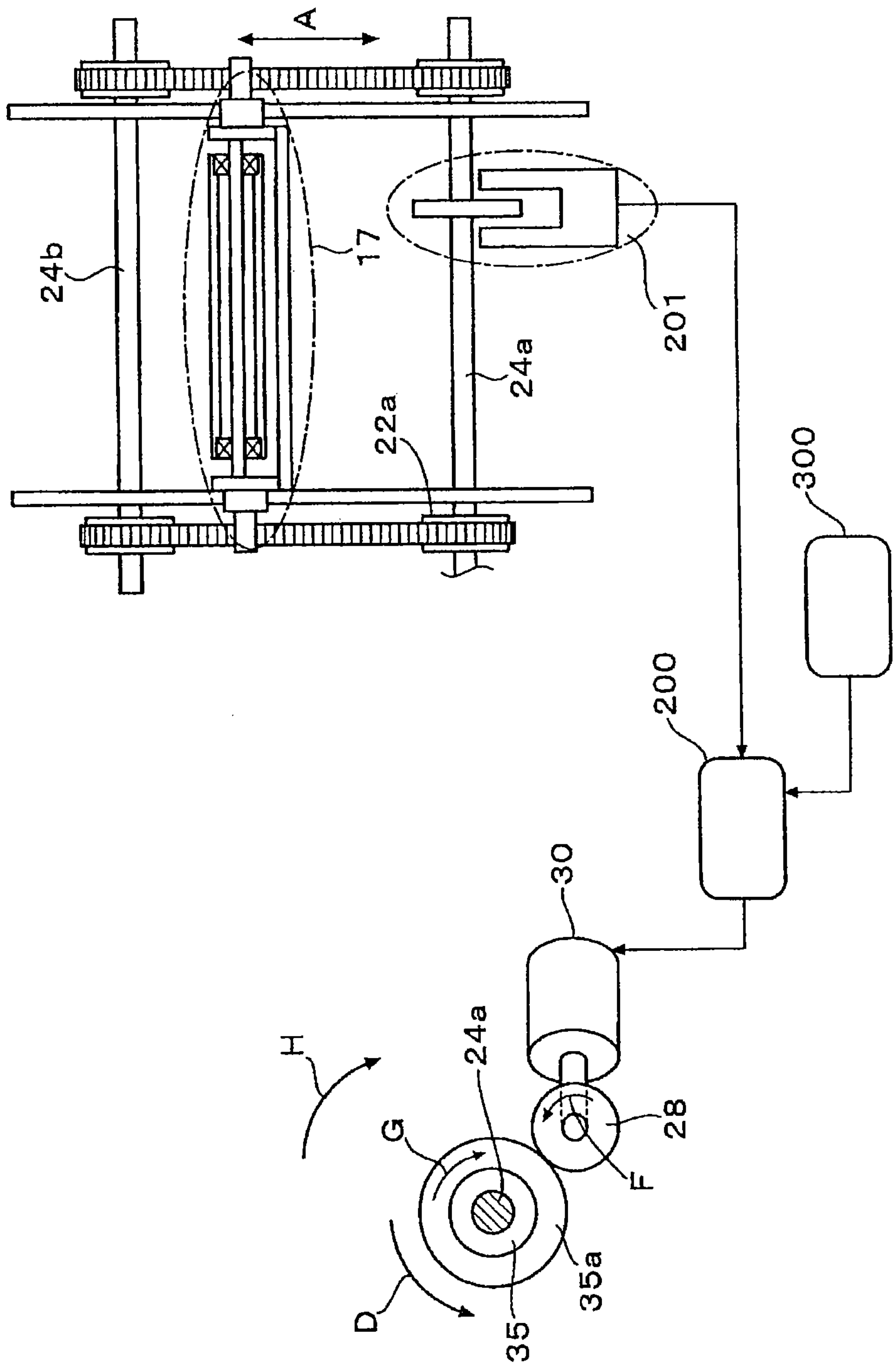


FIG.5

FIG.6A

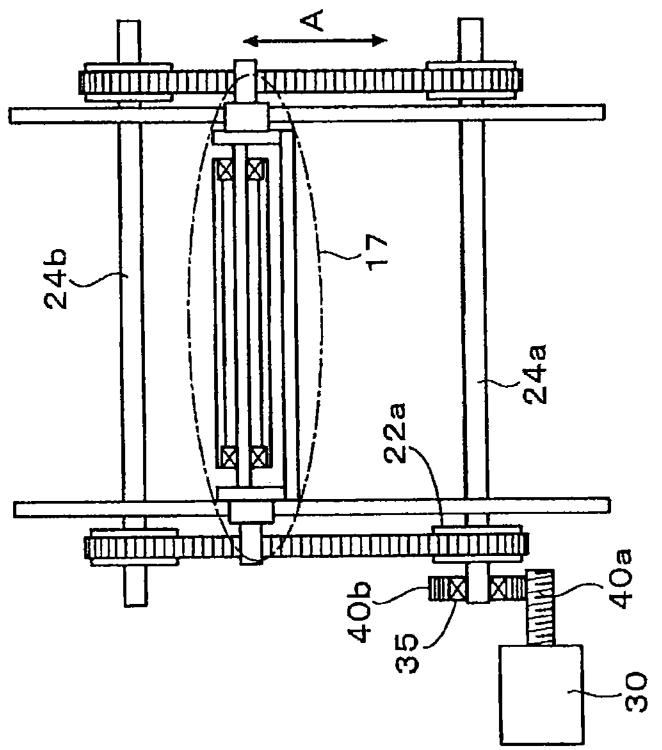


FIG.6B

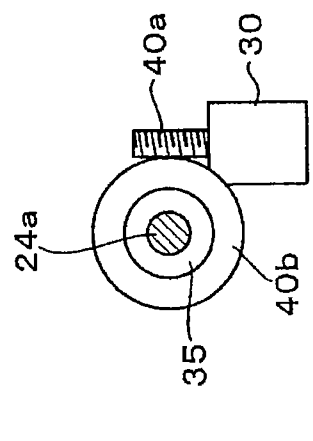


FIG. 7
Prior Art

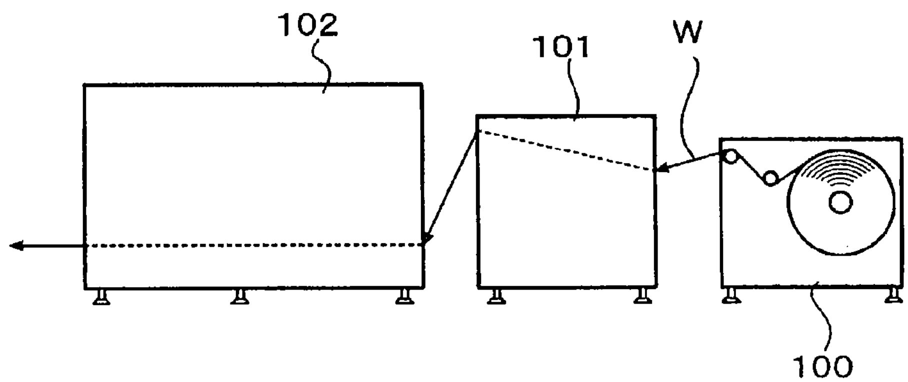


FIG. 8
Prior Art

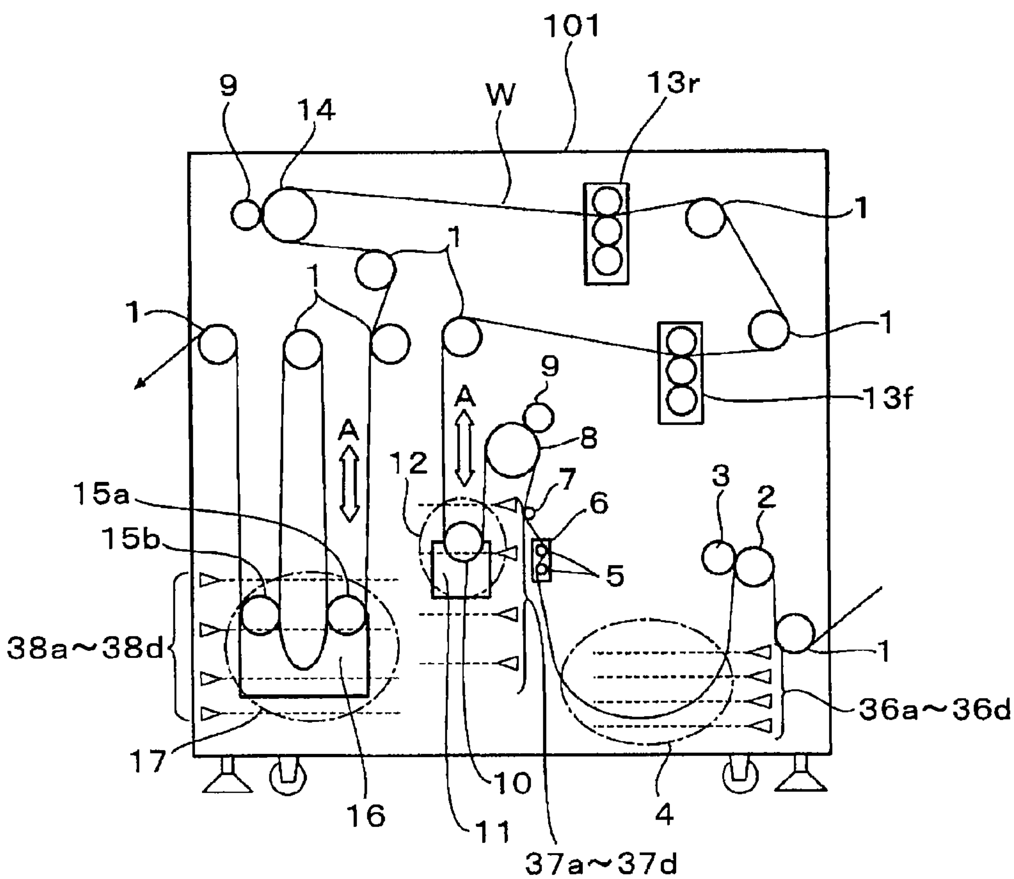


FIG. 9
Prior Art

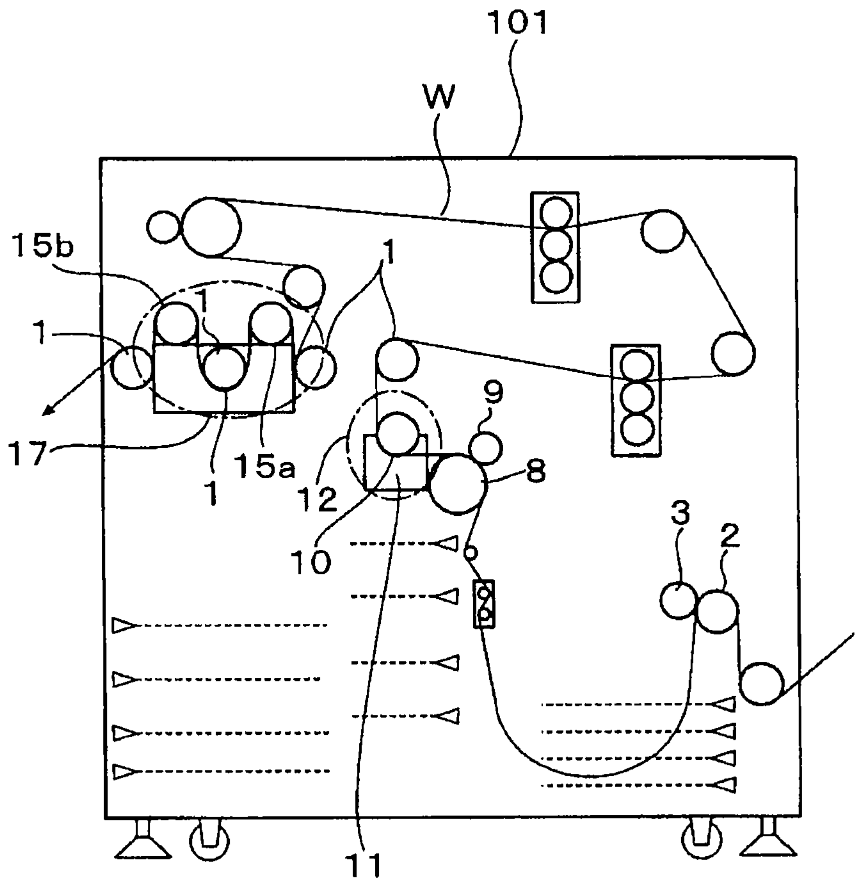


FIG. 10A
Prior Art

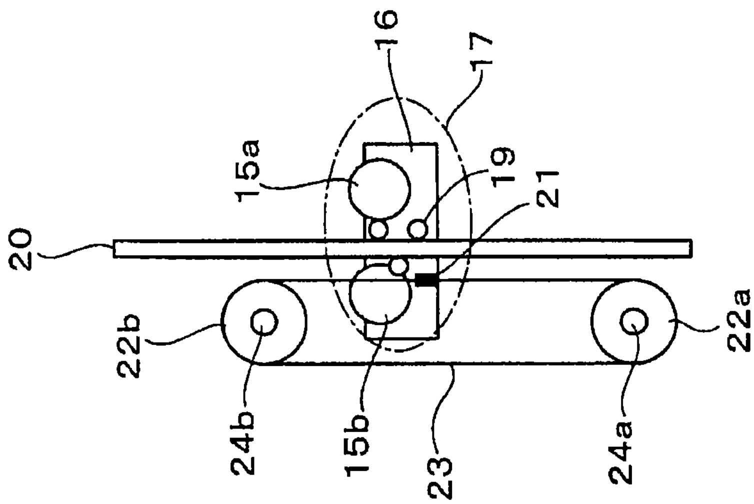


FIG. 10B
Prior Art

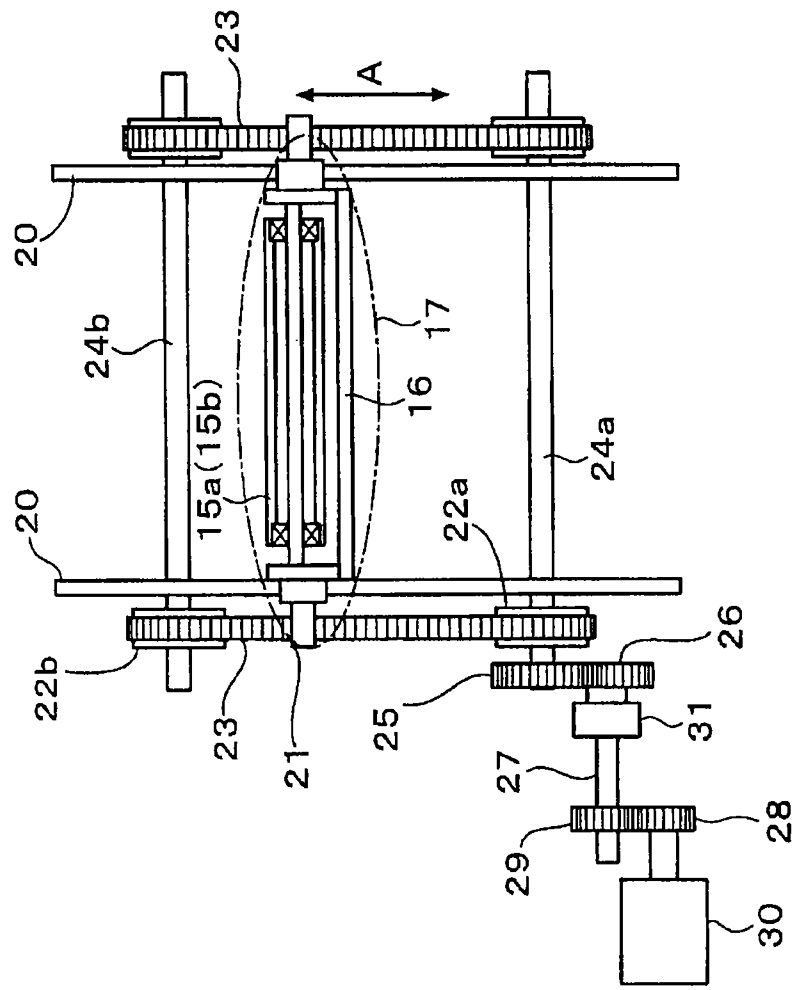


FIG. 11
Prior Art

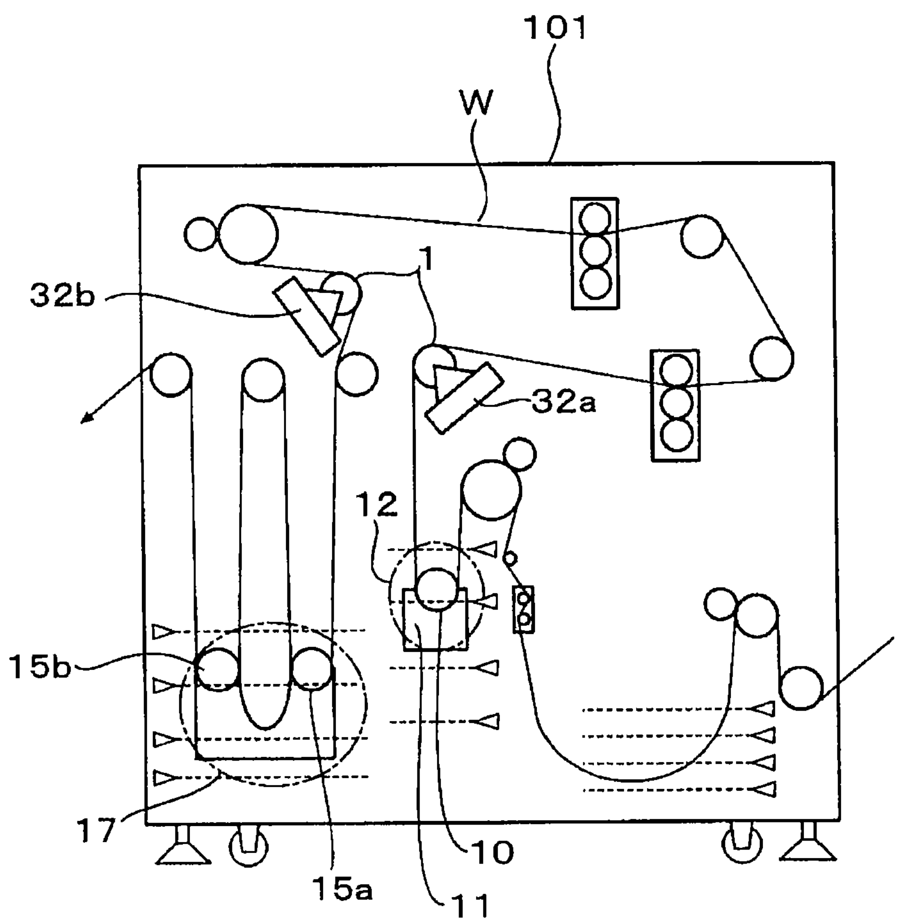
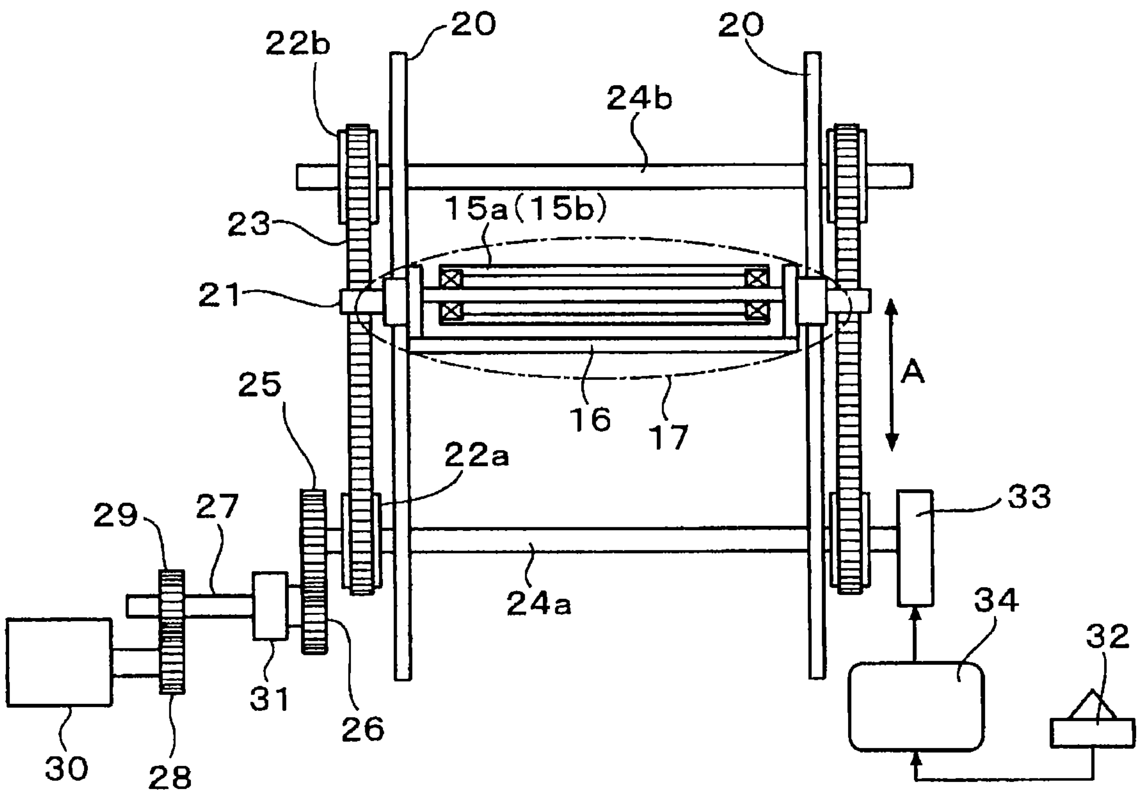


FIG. 12
Prior Art



DANCER ROLLER APPARATUS

TECHNICAL FIELD

The present invention generally relates to a dancer roller apparatus including a dancer roller arranged between a long object conveying unit on the upstream side and a long object conveying unit on the downstream side that is for absorbing an amount of slack of a long object such as a web, for example, and specifically relates to a dancer roller apparatus including a path length switching unit which switches between long object path lengths during conveying of the long object and at the time of loading the long object.

BACKGROUND ART

In an image forming system which includes a printing apparatus which forms an image onto a continuous web; and a web treatment apparatus which applies a specified treatment onto the web before or after printing, or a pre-treatment and post-treatment apparatus which reels out or reels in a roll-shaped web, there often exists multiple web conveying units on a web conveying path within the system. In this case, in general, a dancer roller apparatus is arranged so that an amount of slack of the web between a web conveying unit on the upstream side and a web conveying unit on the downstream side is absorbed and a proper tension is applied onto a web to be conveyed.

FIG. **7** is an overview configuration diagram showing one example of a flow of an inkjet image forming system.

In the system as shown, a web W, which is sent out from a paper-feeding apparatus **100**, is sent into a treatment agent applying apparatus **101** and has applied onto an image forming face thereof a treatment agent which includes a function of coagulating ink before ink droplets impact on the web in order to solve problems such as blur, density, color tone, offset, etc. Depending on a desired printed matter, a face onto which a treatment agent is to be applied may be a single face or a double face.

Next, the web W is sent into a first inkjet printer **102**, which ejects ink droplets on the front side of the web W, so that a desired image is formed thereon. Then, a front and a back of the web W are reversed by a turnover apparatus (not shown), and the web W is continuously sent into the second inkjet printer (not shown), ink droplets are ejected onto the back side of the web W, so that a desired image is formed. Then, the system is arranged such it is sent to a post-treatment apparatus in which a predetermined post-treatment is performed thereon.

FIG. **8**, which is a schematic configuration diagram showing one example of the treatment agent applying apparatus **101** which is used in this image forming system, shows a state at the time the treatment agent is applied.

As shown, a large number of guide rollers **1**, each having a bearing (not shown) at both ends thereof to be rotatably supported thereby, are arranged within the treatment agent applying apparatus **101** to secure a conveying path of the web W. A lead-in roller **2** is rotationally driven by a driving source (not shown) such as a motor and a nip roller **3** is pushed to the lead-in roller **2** side due to a pull tension of a spring (not shown). The lead-in roller **2** and the nip roller **3** may be rotated to lead in the web W from the paper-feeding apparatus **100** to inside this treatment agent applying apparatus **101**.

Moreover, the web W which is sent out of the lead-in roller **2** and the nip roller **3** forms an air loop **4** with some slack, an amount of which slack within the air loop **4** is monitored by slack amount detecting units **36***a*-**36***d*, which include optical sensors arranged in multiple steps, and the lead-in roller **2** is driven and controlled such that the amount of slack becomes constant.

The web W which has passed through the air loop **4** passes between a path shaft **5** and an edge guide **6**. Two path shafts **5** are arranged in a direction which is orthogonal to a conveying direction of the web W, which passes between the path shafts **5** in an S shape. A pair of edge guides **6** is supported by the path shafts **5** and a dimension of a gap between the edge guides **6** is set generally the same as a width dimension of the web W. Therefore, a running position of the web W in a width direction can be regulated.

The edge guide **6** is fixed to the path shaft **5** with a screw, for example, so that a position thereof can be adjusted in accordance with a width dimension of the web W used.

Prior to a stage in which the web W, which has passed between the path shafts **5** and the edge guides **6**, is sent into a feed nip roller **9** which is pressed against by an in feed roller **8** and a spring (not shown), a moderate tension is applied thereto in order to suppress folding or crawling. In the example shown, winding friction is added to a tension shaft **7**. The infeed roller **8** is rotationally driven by a driving source (not shown) such as a motor, etc., and conveys the web in cooperation with the feed nip roller **9**.

The web W which has passed through the infeed roller **8** is wound around in a U shape from the bottom side of a single first dancer roller **10**, which is rotatable. The first dancer roller **10** is rotatably mounted on a first movable frame **11** via a bearing (not shown) which is provided at a roller end portion. Therefore, an encompassing first dancer roller mechanism **12** is hung by the web W.

This first dancer roller mechanism **12** can be moved along gravity directions (upward and downward directions) A. Also are provided first dancer roller mechanism position detecting units **37***a* to **37***d* which detect a position of the first dancer roller mechanism **12**; in accordance with an output of the position detecting units **37***a* to **37***d*, a driving source of the infeed roller **8** may be controlled to increase or decrease speed to regulate a position of the first dancer roller mechanism **12**.

The web W, which has passed through the first dancer roller mechanism **12**, successively passes through a front face applying unit **13***f* which applies on the front face side thereof a treatment agent and a back face applying unit **13***r* which applies on the back face thereof the treatment agent, so that the treatment agent is applied on both faces of the web W. The treatment agent applying unit **13** is not substantially relevant to the present invention, so that an explanation thereof is omitted.

The web W which has passed through the back face applying unit **13***r* passes through an out feed roller **14** which is rotationally driven by a driving source (not shown) such as a motor, etc., and another feed nip roller **9** which is pushed to the outfeed roller **14** side by a spring (not shown). The outfeed roller **14** is rotationally driven by a driving source (not shown) such as a motor, etc., and conveys the web W in cooperation with the other feed nip roller **9**.

Next, the web W is wound, in a W shape, around two second dancer rollers **15***a* and **15***b*, which are rotatable, and a guide roller **1** which is arranged between the dancer rollers **15***a* and **15***b*. The two dancer rollers **15***a* and **15***b* are rotatably mounted to a second movable frame **16** via a bearing (not shown) which is provided to a roller end portion to configure a second dancer roller mechanism **17**. Therefore, this second dancer roller mechanism **17** is hung by the web W.

This second dancer roller mechanism **17** is also movable along gravity directions (upward and downward directions) A, and also provided are multiple-step second dancer roller mechanism position detecting units **38**a-**38**d, which detect a position of the second dancer roller mechanism **17**, so that a driving source of the out feed roller **14** may be controlled to increase or decrease speed in accordance with an output of the position detecting units **38**a to **38**d to regulate a position of the second dancer roller mechanism **17**.

In this way, the web W, which has passed within the treatment agent applying apparatus **101**, is sent into the first inkjet printer **102** on the downstream side as shown in FIG. **7**.

Here, with respect to the in feed roller **8** and the out feed roller **14**, it is difficult to cause the web conveying speeds thereof to completely match due to a rotational speed error, etc., of a driving source (not shown) or a machining error of a roller diameter. Therefore, a difference of the web conveying speeds can be absorbed by a buffer function of the first dancer roller mechanism **12** to perform continuous conveying.

In other words, if a rise in a position of the first dancer roller mechanism **12** is detected, driving and control are performed such that a rotational speed of the in feed roller **8** which is positioned on the upstream thereof is increased to lower the position of the first dancer roller mechanism **12**. Conversely, if a drop in a position of the first dancer roller mechanism **12** is detected, driving and control are performed such that a rotational speed of the in feed roller **8** is decreased to raise the position of the first dancer roller mechanism **12**.

Similarly, the second dancer roller mechanism **17** also absorbs a difference in a web conveying speed between a conveying roller (not shown) which determines a web sending-in speed within the first inkjet printer **102** and the outfeed roller **14**.

Moreover, the first dancer roller mechanism **12** and the second dancer roller mechanism **17** apply tension to the web W with weights thereof, so that, for the first dancer roller mechanism **12**, the tension which is applied to the web W is one half the mechanism weight since it is hung by the web W which is wound around in a U shape, while, for the second dancer roller mechanism **17**, the tension which is applied to the web W is one fourth the mechanism weight since it is hung by the web W which is wound around in a W shape.

A related-art dancer roller mechanism has a buffer function, so that a path of the web W becomes complex as shown in the second dancer roller mechanism **17** in FIG. **8**, etc.

Leaving the path complex causes loading of the web W to be difficult, so that there is commercialized an apparatus, wherein, at the time of loading the web, as shown in FIG. **9**, the first dancer roller mechanism **12** and the second dancer roller mechanism **17** are raised and a length of a path which continues to the guide roller **1** is shortened to improve operability of web loading.

FIG. **10**A is a schematic configuration diagram of a dancer roller apparatus as viewed from the front face; and FIG. **10**B is a schematic configuration diagram for explaining a driving system of the dancer roller apparatus as viewed from the side face.

As shown in FIGS. **10**A and **10**B, two rail shafts **20** are arranged with a predetermined gap along gravity directions (upward and downward directions) A, between which two rail shafts **20** the second dancer roller mechanism **17** is arranged. As shown in FIG. **10**A, on the side face of the movable frame **16** is fixed a multiple number (three in this example) of shaft guides **19**, among which the rail shaft **20** is placed.

Moreover, the second movable frame **16** is connected to a timing belt **23** by a belt clamper **21**. The timing belt **23** is stretched between timing pulleys **22**a and **22**b which are respectively placed thereabove and therebelow, while the timing pulleys **22**a and **22**b are respectively fixed with keys (not shown), etc., to both ends of elevating axles **24**a and **24**b.

The timing pulley **22**a which is supported at one end of the elevating axle **24**a is connected to a motor **30** via drive transmission gears **25** and **26**; a drive axle **27**; and drive gears **28** and **29**. Therefore, this motor **30** may be rotationally driven to raise or lower the second dancer roller mechanism **17** along the rail shafts **20**.

The above-described drive system becomes a load during conveying of the web, so that the dancer roller mechanism **17** affects an operation of absorbing a change in a path length of the web W. In other words, when the drive system becomes the load in the process of the dancer roller mechanism **17** being raised (the path being shortened), a tension applied to the web W increases by an amount corresponding to the load of the drive system in addition to a self weight of the dancer roller mechanism **17**.

Conversely, when the drive system becomes the load in the process of the dancer roller mechanism **17** being lowered (the path being lengthened), an operation of the dancer roller mechanism **17** becomes slower, causing the web W to loosen as it cannot follow a change of the path, and causing the web W to become free (without tension).

In order to prevent this, an electromagnetic clutch **31** is provided within a drive transmission system. In an example in FIGS. **10**A and **10**B, the electromagnetic clutch **31** is arranged between the drive transmission gear **26** and the drive axle **27**, and, therefore, when the electromagnetic clutch **31** is turned off during web conveying to separate an operation of the dancer roller mechanism **17** from the drive system, elevating of the dancer roller mechanism **17** causes the elevating axle **24** and the drive transmission gears **25** and **26** to rotationally operate, but the drive axle **27** does not rotate. When forced elevating of the dancer roller mechanism **17** is necessary, such as at the time of web loading, the electromagnetic clutch **31** is turned ON to connect the drive system and the dancer roller mechanism **17** and the motor **30** is rotationally driven to cause an elevating operation of the dancer roller mechanism **17**.

A configuration, a control operation, etc., of the dancer roller apparatus are described in below-described Patent Documents 1 to 3, for example.

PATENT DOCUMENTS

Patent Document 1: Japanese Utility Model Application Publication No. 03-50128;

Patent Document 2: JP2007-230719A; and

Patent Document 3: JP2002-29652A

With a configuration as shown in FIGS. **10**A and **10**B, a problem such as the following arises:

During the web conveying, the dancer roller mechanism **17** is hung by the web W, so that, when the web W breaks due to jamming, etc., during the web conveying, the dancer roller mechanism **17** has undergoes a free fall. The dancer roller mechanism **17**, which has undergone the fall, collides with a floor face (or a stopper) of the apparatus and is damaged, or the movable frame **16** is deformed, causing a degree of parallelization of the dancer rollers **15**a and **15**b to deviate.

When the dancer roller mechanism **17** breaks, the apparatus needs to be stopped due to component replacements, causing productivity to decrease. Moreover, when the degree of parallelization of the dancer rollers **15**a and **15**b deviates, stability of web conveying decreases, causing an irregularity in applying the treatment agent with the treatment agent applying apparatus **101**. Furthermore, when a similar phenomenon occurs with the dancer roller mechanism which is used in a printing apparatus, printing quality decreases.

This dancer roller mechanism **17** provides a tension to the web W with a self weight, so that, when a web tension is set to 5 Kg, the self weight of the dancer roller mechanism **17** of 20 Kgf is needed, while it is necessary to increase a mechanism weight by an amount corresponding to the web tension. Therefore, when the web W breaks as described above, an impact of the dancer roller mechanism **17** colliding onto an apparatus floor face increases and seriousness of the problem also becomes salient. Here, while a configuration, etc., are explained taking the second dancer roller mechanism **17** as an example, the same also applies to the first dancer roller mechanism **12**.

An apparatus including a mechanism which detects a breakage of the web W as described above is also being commercialized. FIG. **11** is a schematic configuration diagram of the treatment agent applying apparatus **101** including a mechanism which detects the breakage of the web W, while FIG. **12** is a schematic configuration diagram as viewed from a side face in order to describe a drive system of the dancer roller apparatus used in the treatment agent applying apparatus **101**.

As shown in FIG. **11**, a tension detecting unit **32** which detects the tension of the web W is arranged on a web conveying path. In an example in FIG. **11**, a tension detecting unit **32*a*** is provided on an outlet side of the first dancer roller mechanism **12**, while a tension detecting unit **32*b*** is provided on an inlet side of the second dancer roller mechanism **17**. A detection signal from this tension detecting unit **32** (**32*a***, **32*b***) is input into a fall prevention control unit **34** (see FIG. **12**).

Moreover, as shown in FIG. **12**, an electromagnetic brake **33** is attached to the other end of the elevating axle **24*a*** in the dancer roller mechanism **17** and an ON/OFF control of the electromagnetic brake **33** is performed by the fall prevention control unit **34**.

The mechanism is arranged such that, during the web conveying, the electromagnetic brake **33** is turned off so as not to affect an operation of the dancer roller mechanism **17**, whereas, during the web conveying, when the web W breaks, a detected value of the tension detecting unit **32** (**32*a***, **32*b***) generally becomes 0, so that the fall prevention control unit **34** turns on the electromagnetic brake **33** in accordance with this detected value to stop the fall of the dancer roller mechanism **17**.

However, with this configuration, the tension detecting unit **32** (**32*a***, **32*b***), the electromagnetic brake **33**, the fall prevention control unit **34**, etc., are added, so that a structure becomes complex, resulting in a high cost. Moreover, there is a problem such that, when either of the tension detecting unit **32** (**32*a***, **32*b***) and the electromagnetic brake **33** fails, the fall of the dancer roller mechanism **17** may not be prevented.

DISCLOSURE OF THE INVENTION

An object of the present invention is to provide a dancer roller apparatus which does not undermine a dancer roller moving function for loading a long object; and a long object tension applying function and a buffer function during conveying of the long object such as a web, for example.

According to an embodiment of the present invention, a dancer roller apparatus is provided. The dancer roller apparatus includes a dancer roller which is arranged with a gap on a conveying path of a long object to convey the long object and is provided between a downstream side conveying unit and an upstream side conveying unit to absorb an amount of slack of the long object between the upstream side conveying unit and the downstream side conveying unit and provide tension to the long object; a drive motor for changing a position of the dancer roller during conveying of the long object and at a time of loading to switch a path length of the long object; and a dancer roller position changing unit which transmits a driving force from the drive motor to change the position of the dancer roller, wherein the dancer roller position changing unit is provided with a one way clutch which allows the dancer roller to move in a long object slack direction, and wherein the drive motor is caused to rotate in a direction such that the dancer roller moves the one way clutch in a long object stretching direction during the conveying of the long object.

The present invention makes it possible to provide a dancer roller apparatus which is configured as described above and which does not undermine a dancer roller elevating function for loading a long object; and a long object tension applying function and a buffer function during conveying of the long object.

BRIEF DESCRIPTION OF THE DRAWINGS

Other objects, features, and advantages of the present invention will become more apparent from the following detailed descriptions when read in conjunction with the accompanying drawings, in which:

FIG. **1**A is a schematic configuration diagram as viewed from a front face of a dancer roller apparatus according to a first embodiment of the present invention;

FIG. **1**B is a schematic configuration diagram as viewed from a side face for explaining a drive system of the dancer roller apparatus according to the first embodiment of the present invention;

FIG. **2**A is a diagram illustrating a rotating direction of each member from a motor to an elevating axle during web conveying for a movement of the dancer roller mechanism of the dancer roller apparatus;

FIG. **2**B is a diagram illustrating the rotating direction of each member from the motor to the elevating axle when the dancer roller mechanism is raised at the time of web loading for the movement of the dancer roller mechanism of the dancer roller apparatus;

FIG. **2**C is a diagram illustrating the rotating direction of each member from the motor to the elevating axle when the dancer roller mechanism is lowered for the movement of the dancer roller mechanism of the dancer roller apparatus;

FIG. **3** is a partial schematic configuration diagram of the dancer roller apparatus according to a second embodiment of the present invention;

FIG. **4** is a schematic configuration diagram of the dancer roller apparatus according to a third embodiment of the present invention;

FIG. **5** is a schematic configuration diagram of the dancer roller apparatus according to a fourth embodiment of the present invention;

FIG. **6**A is a schematic configuration diagram as viewed from a front face of a dancer roller apparatus according to a fifth embodiment of the present invention;

FIG. **6**B is a schematic configuration diagram as viewed from a side face of the dancer roller apparatus for explaining a drive system according to the fifth embodiment of the present invention;

FIG. **7** is a schematic configuration diagram showing one example of a flow of an inkjet image forming system;

FIG. **8** is a schematic configuration diagram of one example of a treatment agent applying apparatus used in this image forming system;

FIG. **9** is an overview configuration diagram showing a state in which a related-art first dancer roller mechanism and a second dancer roller mechanism are raised at the time of web loading;

FIG. **10**A is a schematic configuration diagram as viewed from a front face that is for explaining a schematic configuration of the dancer roller apparatus;

FIG. **10**B is a schematic configuration diagram as viewed from a side face that is for explaining a drive system of the dancer roller apparatus for explaining a schematic configuration of the dancer roller apparatus;

FIG. **11** is a schematic configuration diagram of a treatment agent applying apparatus in which a web tension detecting unit is arranged on the web conveying path; and

FIG. **12** is a schematic configuration diagram as viewed from a side face of the drive system of the dancer roller apparatus which is used in the treatment agent applying apparatus.

BEST MODE FOR CARRYING OUT THE INVENTION

Next, drawings are used to explain embodiments of the present invention. A flow of an inkjet image forming system according to embodiments of the present invention is the same as in FIG. **7**. Moreover, a schematic configuration of a treatment agent applying apparatus for use in the image forming system is the same as in FIG. **8**, so that repetitious explanations are omitted.

FIGS. **1**A, **1**B, and **2** are diagrams for explaining the first embodiment of the present invention, where FIG. **1**A is a schematic configuration diagram as viewed from a front face of the dancer roller apparatus used in the treatment agent applying apparatus and FIG. **1**B is a schematic configuration as viewed from a side face thereof for explaining a drive system of the dancer roller apparatus.

As shown in FIGS. **1**A and **1**B, two rail shafts **20** are arranged with a predetermined gap along gravity directions (upward and downward directions) A, between which two rail shafts **20** a dancer roller mechanism **17** is arranged. As shown in FIG. **1**A, on the side face of a movable frame **16** are fixed multiple (three in this example) shaft guides **19**, among which the rail shafts **20** are placed.

Moreover, the movable frame **16** is connected to timing belts **23** by belt clampers **21**. The timing belts **23** are stretched between corresponding sets of timing pulleys **22***a* and **22***b*, while phases of the timing pulleys **22***a* and **22***b* are fixed with keys (not shown), etc., to the respective ends of elevating axles **24***a* and **24***b*.

A drive transmission gear **35***a* which is fixed by press fitting, etc., with a one way clutch **35** inside is installed at one end of the elevating axle **24***a*. This drive transmission gear **35***a* is engaged with a drive gear **28** which is installed at the drive axle of a motor **30** which can rotate forward and backward.

FIGS. **2**A to **2**C are diagrams for explaining a rotating direction of each member from the motor **30** to the elevating axle **24***a* in a case of a movement of the dancer roller mechanism **17**, where FIG. **2**A is a diagram showing a rotating direction of each member during web conveying; FIG. **2**B is a diagram showing a rotating direction of each member when the dancer roller mechanism **17** is raised at the time of loading the web W; and FIG. **2**C is a diagram showing a rotating direction of each member when the dancer roller mechanism **17** is lowered.

A direction for allowing the one way clutch **35** to rotate is set to be a direction in which a slack of the web W occurs (a direction in which the dancer roller mechanism **17** is raised) due to an operation of the dancer roller mechanism **17** when the drive transmission gear **35***a* does not rotate. In other words, when the drive transmission gear **35***a* does not rotate, the dancer roller mechanism **17** may move in a direction in which the slack occurs (a direction in which the dancer roller mechanism **17** is raised), but may not move in a web pull tension direction (a direction in which the dancer roller mechanism **17** is lowered).

At the time of loading the web W, it is necessary to raise the dancer roller mechanism **17** as shown in FIG. **9** to shorten a length of a path which continues with the guide roller **1** to improve operability of web loading.

Here, in order to raise the dancer roller mechanism **17**, as shown in FIG. **2**B, when the motor **30** (the drive gear **28**) is rotationally driven in a clockwise B direction, the drive transmission gear **35***a*, which is engaged with the drive gear **28**, rotates in a counterclockwise C direction. An arrow D direction, which shows a lock direction of the one way clutch **35**, is a direction in which a housing locks when an axle is fixed, or a direction is which axle rotating is allowed when the housing is fixed.

As described above, when the drive transmission gear **35***a* rotates in a counterclockwise C direction, the one way clutch **35** is in a lock state, so that rotational drive is transmitted to the elevating axle **24***a* via the one way clutch **35** and the elevating axle **24***a* rotates in an arrow E direction.

When the elevating axle **24***a* rotates in an arrow E direction, the dancer roller mechanism **17** is raised via the timing pulleys **22***a*, **22***b*, and the timing belts **23**, causing the slack of the web W to occur, making it possible to shorten a path length of the web W.

In FIG. **2**C, which shows a case in which the dancer roller mechanism **17** is lowered, when the motor **30** (the drive gear **28**) is rotationally driven in a counterclockwise F direction which is reverse that in FIG. **2**B, the drive transmission gear **35***a*, which is engaged with the drive gear **28**, rotates in the clockwise direction G and the one way clutch **35** also rotates in the same clockwise G direction.

This clockwise G direction is not the above-described D direction in which the one way clutch **35** is locked, so that the elevating axle **24***a* does not rotate in a forced manner. Here, there is a running torque applied also on the elevating axle **24** due to a weight of the dancer roller mechanism **17**, so that, as a result, the elevating axle **24***a* also rotates in an arrow H direction with rotating of the drive transmission gear **35***a* and the dancer roller mechanism **17** is lowered.

In this way, in order to switch a path length of the web W such as at the time of web loading, an operation of raising or lowering the dancer roller mechanism **17** is possible.

Next, functions of the dancer roller mechanism **17** at the time of web conveying are described using FIG. **2**A.

As described above, during the web conveying, the dancer roller mechanism **17** is hung by the web W. Thus, the dancer roller mechanism **17** has to move upward and downward in accordance with a change in a web length that changes due to a difference in web conveying speeds between an out feed roller **14** (see FIG. **8**) which is positioned on the upstream side of the web conveying direction of the dancer roller mechanism **17** and a conveying roller (not shown) which determines a web sending in speed within the inkjet printer **102** (see FIG. **7**) which is positioned on the downstream of the web conveying direction.

Here, when the web length becomes short, or, in other words, when it is necessary for the dancer roller mechanism **17** to be raised, the one way clutch **35** is not in a lock direction, so that the dancer roller mechanism **17** can undergo a raising operation, hung by the web W.

Moreover, conversely, when the web length becomes long, or, in other words, when it is necessary for the dancer roller mechanism **17** to be lowered, the one way clutch **35** is in a lock direction, so that, in this state, the dancer roller mechanism **17** is not lowered, resulting in a slack to occur in the web W, making it not possible to provide tension to the web, which is a different function of the dancer roller mechanism **17**.

Thus, in the present invention, the one way clutch **35** is caused to rotate in a direction in which the dancer roller mechanism **17** moves in a web stretching direction. In a configuration in FIG. **2**A, the motor **30** (the drive gear **28**) is rotationally driven in the same counterclockwise F direction as in FIG. **2**C (a direction in which the dancer roller mechanism **17** is to be lowered) and the one way clutch **35** and the drive transmission gear **35***a* engage with the drive gear **28** in the clockwise direction G.

In this way, due to a difference in rotational speed between the elevating axle **24***a* and the one way clutch **35**, when the one way clutch **35** is set to be a reference, it is possible to create a state in which the elevating axle **24***a* is relatively rotating in a direction which is not the lock direction, making it possible for the dancer roller mechanism **17** to be lowered by following a change of the web length and to continue providing tension to the web W.

Then, when the web breaks during the web conveying, the timing pulleys **22***a*, **22***b*, and the timing belt **23** operate in accordance with what is to be a rotational speed of the drive transmission gear **35***a*, the one way clutch **35**, and the elevating axle **24***a* that are rotationally driven by the motor **30**, so that the dancer roller mechanism **17** is to be lowered at a specified speed. Therefore, an impact of a collision due to a related-art free fall of the dancer roller mechanism **17** does not occur, making it possible to prevent breaking, etc., of the dancer roller mechanism **17**. Moreover, a configuration becomes simple relative to a configuration of the related art dancer roller mechanism, so that it is highly reliable and inexpensive.

While a configuration in which the one way clutch **35** is provided in the drive transmission gear **35***a* is explained as one example, it goes without saying that the same advantage is obtained as long as the one way clutch **35** is within the drive transmission system of the dancer roller mechanism **17** and the motor, so that it may be arranged between an axle of the motor **30** and the drive gear **28**, or between the timing pulley **22***a* and the elevating axle **24***a*.

Moreover, while drive transmission from the motor **30** to the elevating axle **24***a* is performed by the gears in FIGS. **1** and **2**, it may be arranged for the drive transmission system to be a timing pulley and a timing belt, and for the timing pulley to be provided with the one way clutch.

FIG. **3** is a partial schematic configuration diagram of the dancer roller apparatus according to a second embodiment of the present invention. In this embodiment, a setting input unit **50** for setting a rotational drive speed of the motor **30** within the web conveying is provided, and the setting input unit **50** is connected to the motor **30**.

In the first embodiment, while the dancer roller mechanism **17** can be moved in raising and lowering directions in accordance with a change of the web length, there is a constraint due to a lock function of the one way clutch **35** only for the lowering direction. In other words, it is not possible for the rotational speed of the elevating axle **24***a* to exceed the rotational speed of the one way clutch **35**.

When the rotational speed of the elevating axle **24***a* in accordance with the lowering operation of the dancer roller mechanism **17** is about to exceed the rotational speed of the one way clutch **35**, it is not possible to perform the lowering operation of the dancer roller mechanism **17** at a speed which is greater or equal to a speed in accordance with the rotational speed of the one way clutch **35** due to a lock function of the one way clutch **35**, thus causing a slack to occur in the web W, making it not possible to provide tension to the web W, which is a different function of the dancer roller mechanism **17**.

In the present embodiment, in order to avoid this, a rotational drive speed of the motor **30** is input and determined by the setting input unit **50**, so that there is no functional problem. For example, when a web conveying speed of a conveying roller (not shown) which determines a web sending in speed within the inkjet printer **102** that is to be a reference is 120 m/min (=2 m/s) and a web conveying speed of the out feed roller **14** (see FIG. **8**) for performing position control of the dancer roller mechanism **17** is controlled to be between 114 m/min (=1.9 m/s) and 126 m/min (=2.1 m/s), the lowering speed of the dancer roller mechanism **17** becomes, at a maximum, a speed in accordance with a changing speed of the web length that is 0.1 m/s=100 mm/s at a maximum.

When the dancer roller mechanism **17**, as in accordance with the present embodiment, is wound in a W shape and hung by four webs W, a lowering speed of the dancer roller mechanism **17** becomes one fourth a changing speed of the web length, so that it becomes 25 mm/s at a maximum. In other words, when the motor **30** is caused to rotate at a speed which may lower the dancer roller mechanism **17** at a speed such that the lowering speed of the dancer roller mechanism **17** exceeds 25 mm/s, or, 30 mm/s by nature, the above-described problems may be avoided. When a diameter of the timing pulley **22***a* is around 36 mm and a reduction gear ratio is around 40, it may be rotationally driven around

$$30\ \text{mm/s}\div(36\ \text{mm}\times\pi)\times 40\approx 10.6\ \text{rps}\ (\approx 640\ \text{rps}).$$

In this way, an operation becomes possible without any constraints within a range of actual use even for movement to a lowering direction of the dancer roller mechanism **17**, making it possible to provide a dancer roller mechanism which has no functional problem.

For example, when jamming occurs inside the treatment agent applying apparatus **101** as a function of the dancer roller mechanism **17**, it is necessary to secure a buffer amount which allows a downstream inkjet printer **102** to stop safely. When the web conveying speed is reduced from 120 m/min (=2 m/s) to 1 m/s^2, a buffer amount of 2 m, or

$$2\ \text{m/s}\times(2\ \text{m/s}\div 1\ \text{m/s\^{}2})\div 2=2\ \text{m becomes necessary.}$$

For having a web buffer of 2 m (2000 mm), a moving range of at least 500 mm is necessary with the dancer roller mechanism **17** which is wound in a W shape, or, in other words, a free fall of at least 500 mm could occur with the related-art dancer roller mechanism. For the free fall of 500 mm, the falling speed exceeds 3000 mm/s. Moreover, even for the free fall of 1 mm, the falling speed is approximately 140 mm/s, so that 30 mm/s is a sufficiently small value.

Therefore, an impact with which the dancer roller mechanism **17** collides onto an apparatus floor face may be ignored from a practical point of view. Here, the idea is similar for the related art first dancer roller mechanism **12** within the treatment agent applying apparatus **101**, where values to be used are the web conveying speed of the out feed roller **14** and the web conveying speed of the in feed roller **8** and the dancer roller mechanism **12** is hung by two webs, so that a lowering speed of the dancer roller mechanism **12** becomes one half the changing speed of the web length. While a value used in calculating differs depending on a path shape of the web W or a configuration of the dancer roller, it goes without saying that the idea is similar. A required rotational speed of the motor **30** may be calculated from each design specification to set and input the calculated results.

As a different embodiment, a rotational speed of the motor **30** is determined in accordance with the web conveying speed of the out feed roller **14** on the upstream side in the web conveying direction of the dancer roller mechanism **17** and the web conveying speed of the conveying roller (not shown) which determines a web sending in speed within the inkjet printer **102** on the downstream side in the web conveying direction of the dancer roller mechanism **17**.

In other words, the web conveying speed of the out feed roller **14** and the web conveying speed of the conveying roller (not shown) which determines the web sending in speed within the inkjet printer **102** are monitored and operated to calculate a moving speed of the dancer roller mechanism **17** in accordance with a change of the web length, and an operation similar to what is described above is performed, estimating a margin of 120% for the above-described calculated moving speed of the dancer roller mechanism **17**, for example, such that the rotational speed of the elevating axle **24***a* at the time the dancer roller mechanism **17** is lowered does not exceed the rotational speed of the one way clutch **35**, so that the computed value is set to be a rotational drive speed of the motor **30**.

In this way, even when a control range of the web conveying speed of the out feed roller **14** for performing position control of the dancer roller mechanism **17** is changed, it is not necessary to change the rotational drive speed of the motor **30** at any time, making it possible to provide a highly versatile dancer roller mechanism.

Here, for a unit which detects the web conveying speed of the out feed roller **14** and the web conveying speed of the conveying roller which determines the web sending in speed within the inkjet printer **102**, various schemes are possible such as a scheme in which a Doppler velocimeter, etc., is applied onto a web face at each area to perform a detection directly, or an indirect scheme in which a rotational speed of each roller is detected by an encoder to perform an operation from a diameter of each roller. However, what kind of unit is used is not relevant to the gist of the present invention.

FIG. **4** is a schematic configuration diagram of the dancer roller apparatus according to a third embodiment.

In the present embodiment as shown in FIG. **4**, a dancer roller moving speed detecting unit **201** which detects a moving speed of the dancer roller mechanism **17** and a motor drive speed control unit **200** which determines and controls a rotational speed of the motor **30** based on a detection signal from the dancer roller moving speed detecting unit **201** are provided.

In the present embodiment, while an example of using a rotational encoder which is mounted to the elevating axle **24***a* and a detector which optically detects a rotational amount of the rotational encoder is shown as the dancer roller moving speed detecting unit **201**, regardless of what scheme carried out in the related art is used, the scheme which detects the moving speed of the dancer roller mechanism **17** is not relevant to the gist of the present invention.

An operation similar to what is described above in performed based on information of the dancer roller moving speed detecting unit **201** and a rotational speed of the motor **30** is determined and controlled by the motor drive speed control unit **200**.

In this way, an error, etc., due to slipping of the web W is reduced relative to the scheme of detecting the rotational speed of each conveying roller in the upstream and in the downstream, making it possible to more accurately detect a moving speed of the dancer roller mechanism **17**. Therefore, a margin is decreased of the rotational speed of the motor **30** such that the rotational speed of the elevating axle **24***a* does not exceed the rotational speed of the one way clutch **35** to suppress the rotational speed to a required minimum, thereby making it possible to reduce a drive current of the motor **30** and making it possible to reduce abrasion of a gear, etc., which rotate in the configuration.

Moreover, as a different embodiment, it is detected that a moving direction of the above-described dancer roller mechanism **17** is a raising direction (a direction which allows rotating of the one way clutch **35**), or, when a calculation is performed with an operation, a rotation of the motor **30** is stopped. In a general positional control of the dancer roller mechanism **17**, a time of moving toward a raising direction and a time of moving toward a lowering direction relative to a specified position are generally equivalent. As rotation of the one way clutch **35** is allowed when the moving direction of the dancer roller mechanism **17** is a raising direction, there is no functional problem even when the motor **30** is not driven, so that rotation of the motor **30** is required at a rotational speed with no problem for an actual use only when a moving direction of the dancer roller mechanism **17** is a lowering direction.

Therefore, with such an operation, a time of rotating the motor **30** becomes generally half the total web conveying time, making it possible to suppress to a minimum abrasion of a gear, etc., which rotates in the configuration and the drive current.

Moreover, in a different embodiment, in a configuration in which a dancer roller moving speed detecting unit **201** which detects a moving speed of the dancer roller mechanism **17** is provided as shown in FIG. **4**, wherein, when a thereby detected or computed moving speed of the dancer roller mechanism **17** in a lowering direction reaches an original moving speed of the dancer roller mechanism **17** in the lowering direction in accordance with a rotational speed of the motor **30**, an error signal is emitted.

This state occurs when the web W breaks, or when a difference between the web conveying speed on the upstream side and the web conveying speed on the downstream side of the dancer roller mechanism **17** becomes larger than anticipated, so that, as a result, the lowering speed of the dancer roller mechanism **17** cannot catch up with the changing speed of the web length and a slack occurs in the web W of the part. Therefore, an error may be issued to prevent the apparatus from continuing web conveying when the web breaks and to prevent a provision of works with degraded printing image quality which occurs as a result from the slack occurring in the web W.

FIG. **5** is a schematic configuration diagram of the dancer roller apparatus according to a fourth embodiment. In this embodiment is provided an upper limit speed setting input unit **300** which sets and inputs an upper limit speed of the motor **30**, which upper limit speed setting input unit **300** is connected to the motor drive speed control unit **200**.

In the previously-described embodiments, a rotational driving speed of the motor **30** is determined such that the rotational speed of the elevating axle **24***a* in accordance with a moving direction in a lowering direction of the dancer roller mechanism **17** does not exceed the rotational speed of the one way clutch **35**. The dancer roller mechanism **17** is lowered in accordance with a rotational speed of the motor **30** when the web W breaks during web conveying.

While it is a matter of course that the lowering speed is a speed which does not cause breakage when the dancer roller mechanism **17** collides onto an apparatus floor face, various speeds to be an upper limit are possible depending on conditions to be taken into account, such as a speed with which a sound of collision may be allowed, or a speed with which a service life of the motor **30** itself may be secured, for example.

Therefore, as in this embodiment, the upper limit speed setting and inputting unit **300** may be provided and connected to the motor drive speed control unit **200** to set an upper limit of the rotational speed of the motor **30** to an optimal value in that condition even in various conditions as described above.

FIG. **6**A is a schematic configuration diagram as viewed from a front face of a dancer roller apparatus according to the fifth embodiment, and FIG. **6**B is a schematic configuration diagram as viewed from a side face for describing a drive system of the dancer roller apparatus.

In this embodiment, a worm gear **40** is used as a drive transmission unit which transmits a drive power of the motor **30**. As shown in FIGS. **6**A and **6**B, this worm gear **40** includes a worm **40***a* which is provided on the rotational axle side of the motor **30** and a worm wheel **40***b* which is provided on the one way clutch **35** side.

As it is not possible to cause it to rotate from the worm wheel **40***b* side due to a self stopping property of the worm gear **40**, the elevating axle **24***a* does not rotate even when the motor **30** does not have a stop torque, and, thus, the dancer roller mechanism **17** does not fall. Such a configuration makes it possible to prevent a fall of the dancer roller mechanism **17** even when a web breaks during web conveying and magnetic excitement to the motor **30** is stopped.

While a configuration is described in the present embodiment of hanging a dancer roller mechanism **17** with a web W and providing tension to the web W with a self weight of the dancer roller mechanism **17**, a problem in which the dancer roller mechanism collides onto a stopper, etc., due to a spring force is similar to when the web breaks even for a dancer roller mechanism with a configuration in which, for example, a dancer roller moves in a horizontal direction, wherein the dancer roller is pulled with a spring force to provide tension to the web, or a dancer roller mechanism with a configuration in which a dancer roller is supported to a tip of an oscillating lever, which is pulled to a web tension increasing direction due to a spring force, making it possible with a configuration of the present invention to prevent the dancer roller mechanism form colliding with a stopper, etc.

While a case of using a web which is continuous as a long object is described in the above-described embodiments, the present invention is also applicable to a dancer roller apparatus which handles other long-shaped objects such as cloth, synthetic resin film, a string shaped object, etc.

The present application is based on Japanese Priority Application No. 2012-097800 filed on Apr. 23, 2012, the entire contents of which are hereby incorporated by reference.

The invention claimed is:

1. A dancer roller apparatus, comprising:

a dancer roller which is arranged with a gap on a conveying path of a long object to convey the long object and is provided between a downstream side conveying unit and an upstream side conveying unit to absorb an amount of slack of the long object between the upstream side conveying unit and the downstream side conveying unit and provide tension to the long object;

a drive motor for changing a position of the dancer roller during conveying of the long object and at a time of loading to switch a path length of the long object, the drive motor including a drive axle; and

a dancer roller position changing unit which includes a drive transmission gear that is installed at one end of an elevating axle, the drive transmission gear being engaged with a drive gear which is installed at the drive axle of the drive motor which can rotate forward and backward, the dancer roller position changing unit configured to transmit a driving force from the drive motor to change the position of the dancer roller,

wherein the dancer roller position changing unit further includes a one way clutch which allows the dancer roller to move in a long object slack direction, and

wherein the drive motor is caused to rotate in a direction such that the dancer roller moves the one way clutch in a long object stretching direction during the conveying of the long object.

2. The dancer roller apparatus as claimed in claim **1**, further comprising a speed setting and inputting unit for setting a rotational speed of the drive motor.

3. The dancer roller apparatus as claimed in claim **2**, wherein the speed setting and input unit is configured to calculate a position moving speed of the dancer roller based on a difference in a long object conveying speed of the upstream side conveying unit and the downstream side conveying unit during the long object conveying to determine a rotational speed of the drive motor in accordance with the calculated position moving speed.

4. The dancer roller apparatus as claimed in claim **3**, wherein the dancer roller apparatus is configured to stop rotating of the driving motor when a moving direction of the dancer roller is a slack direction of the long object.

5. The dancer roller apparatus as claimed in claim **3**, further comprising a rotational speed upper limit value setting and inputting unit which sets and inputs an upper limit value of the drive motor rotational speed.

6. The dancer roller apparatus as claimed in claim **2**, further comprising a dancer roller moving speed detecting unit which detects a moving speed of the dancer roller, wherein the dancer roller apparatus is configured to set the rotational speed of the drive motor with the speed setting and inputting unit based on a detected value from the dancer roller moving speed detecting unit.

7. The dancer roller apparatus as claimed in claim **1**, wherein the dancer roller apparatus is configured to determine that there is an error when a moving speed of the dancer roller in the stretching direction of the long object approaches an original moving speed of the dancer roller in dependence on a rotational speed of the drive motor.

8. The dancer roller apparatus as claimed in claim **1**, wherein a worm gear is used as a driving force transmission unit of the dancer roller position changing unit.

* * * * *